Homo Erectus & Homo Sapiens in Spectrum of Volcanic Ecology, Narmada Valley, Madhya pradesh India

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Abstract— The Quaternary tract of Narmada basin covers an area of abut 12950 sq.km starting from west of Jabalpur ($23^0 07^0 790530$) to east of Handia (22^0 29'; 76^0 58') for a distance of about 320 km. It is found to be ideal locus of Quaternary sedimentation in Central India, as witnessed by multi-cyclic sequence of Quaternary terraces in the valley. The total estimated thickness of Quaternary sediments in the central sector of Narmada is about 325 m. where the level of Ash bed occurrence has been identified at the depth between 75-83 m of Quaternary column of valley. The Quaternary blanket consists of sediments of three domains viz. glacial, fluvio- glacial and fluvial, which were deposited in distinct environments during Quaternary time. The Boulder Bed (20 to 260 m.) below ground level is of glacial origin, comprised of thick pile of sediments occupied at the base of rock basin and were deposited by glacial activities in dry and cold climatic condition during early Pleistocene time. The fossiliferous bed Boulder conglomerate (260 to 278 m. above m.s.l.) is of fluvio-glacial origin and top four formations in increasing antiquity are Sohagpur, Shahganj, Hoshangabad and Janwasa (278 to 350m. above m.s.l.) are of fluvial origin and represent the complete sequence of Quaternary sedimentation in Narmada valley & Central India Khan & Sonakia (1992).

The skull cap of *Home erectus* (Sonakia1984) and other fauna recorded along with calc- nodules near village Hathnora (22 ° 52" N; 77 ° 52" E) in fossiliferous boulder conglomerate; named as Hathnora formation Khan & Sonakia (1992). It is found to be associated with volcanic Ash bed of Quaternary age in the area around Hathnora, and upstream Khan et.at. (1991). The two levels of horizons of Ash bed identified are designated as NAB-I and NAB-II in ascending antiquity in the valley. The Ash bed NAB-1 is associated lower litho units of boulder conglomerate which is well preserved and persistent where as NAB-II is associated with younger deposits. The NAB-1 contains three micro layer (L-1 to -L3) and NB-II two micro layers (L-4 to L-5) in increasing antiquity.

The study of assemblage of glass matrix of Ash bed, grain morphology of glass their- relation with other minerals shape, size, texture of litho fragments of pyroclastic origin suggest that sediments were brought from distant source by Aeolian agencies in the form of thick cloud containing volcanic dust, rock matrix and different gases which remained in atmosphere for very long time and settled down across the Indian sub continent during the different phases of river sedimentation. Further study of Ash bed material and silica revealed diagnostic morphological characters of glass shards which are typical of silica volcanism (Heiken, 1972, 1974) and show close similarity with those reported from the Quaternary tephra beds of the Narmada , Son, Purna and Kukdi basins (Basu et. al., 1987; Khan et.al. 1991 Basu and Biswas, 1991; Singaraju and Shivaji, (1991) Mukhopadhyay, (1992). It is significant to note that the occurrences and association of two marked horizons at different levels further reveal that the cyclic eruption and settling of volcanic matrix has taken place with pause in the valley.

In Narmada valley the association of Ash bed NAB-I with Hathnora formation at the depth of 78 m in Quaternary column and occurrences skull cape *of Homo erectus* at the depth of 83 m in decreasing antiquity from the top assumed that Toba eruption have taken place later than existence of *Homo erectus* which appeared and resided in the valley for long time before the fall of Toba ash. The association of Ash is NAB-II at the depth of 72 m with the younger deposit revealed the second cyclic fall of Toba ash which certainly have had influenced on hominines and had collective and cumulative impact on *Homo erectus* (Sonakia1984) *Homo sapiens* (Thobold 1860, 81)**,** in Narmada valley and Indian sub-continent.

Using phytogeographic data, Oppenheimer (2003) argues that *Homo. Sapiens* occupied India before ~74 ka and may have undergone "mass extinction" as a result of the Toba eruption. The argument of Oppenheimer (2003) is in strong conformity with the present observation of authors. As sediment & Ash bed sequence of Quaternary column of Narmada (325 m) and occurrences of fossil of skull cape *of Homo erectus* (Sonakia1984) at 83 m & human cranium *Homo sapiens* (Thebold 1960,1981) transported have existed prior to fall of Toba ash and they are among the few who inspite of mass extinction caused by mega dislocation in ecology and environment related with volcanic eruption survived in Narmada Valley. It is further documented by the rarest occurrences of these fossils in subcontinent which also confirm the intensive impact of volcanic ash fall on these hominines and their consequential mass extinction.

Index Terms— Ash beds, Boulder conglomerate, fluvial, fluviao-glacial, glacial, *Homo erectus, Homo sapiens* Pleistocene, Quaternary Platform, sedimentation *Homo sapiens, Home erectus.*

1. INTRODUCTION

The Narmada river originates from the Amarkantak plateau of Satpura Ranges in Rewa at an elevation of about 1057 m (220 40′ -810 45′), flows westerly course for about 1284 kms length across the middle of Indian subcontinent before entering Gulf of Cambay in the Arabian sea near Baroda in Gujarat state. The course of Narmada is conspicuously straight and is controlled by ENE_WSW to E_W lineament, bounded by Vindhyan in the north and Satpura in the south. The valley has maximum width of about 32 kms.

The Quaternary tract of Narmada basin covers an area of abut 12950 sq. km starting from west of Jabalpur ($23^0 07^0 790530$) to east of Handia (22^0 29′; 76^0 58′) for a distance of about 320 km. It is found to be ideal locus of Quaternary sedimentation in Central India as witness by multi-cyclic sequence of Quaternary terraces in the valley. The total estimated thickness of Quaternary sediments in the central sector of Narmada is about 325 m. where the level of Ash bed occurrence has been identified between the depths of 75-83 m of Quaternary column in unified Quaternary Platform.

The Quaternary sediments of Narmada valley represent the thickest deposits in peninsular India Khan and Sonakia (1992). Beside association of fossils and tool assemblage these deposits are also associated with Ash bed Khan et.al (1991). The major climate events and consequential resultant sedimentary weathering and geomorphic events are well dated by radio carbon dating in the Son valley, and Kukdi valley of western Maharashtra, by fission track age of the associated tephra beds. Chronology of the earlier Quaternary events (Middle and Lower Pleistocene). Magneto-statigraphic studies are being carried out by (Rao, et.al 1997).

In recent years occurrences of volcanic ash beds in association with the Quaternary sediments has been reported from different river basins of Indian subcontinent, Acharya, et.al. (1993). the first report on occurrence of Quaternary volcanic ash in India was by Williams and Royee (1982). Acharya, et.al (1993) described toba ash and used it as tool for correlation of late Pleistocene alluvium. William& Clarke (1995) and subsequently similar occurrences were reported by several workers. Khan et.al (1991) identified two horizons of Ash bed one above the boulder conglomerate and other in the younger deposit. He further reported various micro layers in these beds and designated as L-1 to L-5 in increasing antiquity of Quaternary stratigraphic column.

2. PRESENT WORK

Khan, et.al. (1991) reported & described Ash bed from Narmada valley associated with Hathnora formation in the central sector of Narmada valley. He described two levels of Ash Beds and their micro units. The present paper documents the results of chemical, petrographical mineralogical, X- ray analysis and study of Quartz grain morphology of Ash bed and their micro layers NAB-I (L-1 to L-3) and Ash bed NAB- II (L-4 to L-5) form the Hathnora formation which has yielded the skull cap of *Homo erectus* (Narmada Man) Sonakia (1982). Besides the impact of Ash Fall on hominines due to volcanic eruption and dislocation of ecology and environments is also attempted.

3. NARMADA RIFT VALLEY

In Central India SONATA LINEAMENT ZONE embodies the two Quaternary basins of tectonic origin on the two margins of Satpura Crustal Block Namada & Tapti. The associated Narmada South (Satpura North) fault and Satpura South Fault marking the two hinges of the Satpura block are fundamental in nature and extend to Moho level. The Narmada Quaternary basin in the north and Tapti-Purna basin in the south are flanking Satpura.The Satpura Range, trending ENE-WSW forms a prominent morph tectonic unit in the area bound by Lat. $20^{\circ}43'$N & $23^{\circ}30'$N and longitudes $73^{\circ}52'$E and $81^{\circ}30'$E, between Rajpipla, (Gujarat) in the West and Maikal Ranges (Madhya Pradesh) in the east. The Satpura block is flanked in the North by Collinear Valleys of

Narmada and Son and in the South by Tapti-Purna; Kanhan, Pench and Wainganga rivers flow across the southern slopes in the eastern part.

The area studied tectonically encompasses two crustal provinces of Central India Shield, namely, the Northern Crustal Province (NCP) and the Southern Crustal Province (SCP (Acharyya and Roy, 1998; Roy, 1988). The two provinces are separated by a crustal level shear zone, referred as Central Indian Suture (CIS Jain et al. 1995). The southern part of the NCP, containing the Satpura and son Narmada (SONA) valley geographic domain, is known as Central Indian Tectonic Zone (CITZ; Radhakrishna and the CITZ are marked by Narmada North Fault (NNF) in the north and CIS in the south (Acharyya, 1999).

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The study of tectonic set up of Narmada valley, surface manifestation and geo-physical data shows that the Son-Narmada and Tapti lineament together represent an intraplate rift with a central (Satpura Block) horst bounded on either side by grabens: the Narmada graben on the north and the Tapti graben to the south (Mishra et al, 1999).

The catchment area of the river, bordered by the Satpura and Vindhya Mountain Ranges, stretches over a territory of 98,796 km2 (38,145.3 sq mi). It is situated between longitudes 72°32' and 81°45' east and latitudes 21°20' to 23°45' north, on the northern edge of the Deccan Plateau. The catchment area encompasses important regions in Madhya Pradesh, Gujarat, and Maharashtra.

The Quaternary tract of Narmada basin covers an area of about 17950 sq. km starting from west of Jabalpur ($23^0 07^0 79$ 05 30) to east of Harda (22^0 29′; 76^0 58′) , and Gureshwar and Bharouche section in Gujarat state for a distance of about 1320 km. It is found to be ideal locus of Quaternary sedimentation in Central India as witness by multi-cyclic sequence of Quaternary terraces in the valley. The general elevation of Narmada alluvial plain varies between 265.7 and 274.3 m above the sea level. The general gradient of this plain in this stretch is about 1m /Km towards West.

The principal tributaries of Narmada River are Sher Sakkar Dudhi inTawa and Ganjal in, Hiran& Gaur. The Man, Karjan, Madhumati, Heran and Orsang, Amravati Narmada valley originate from the Satpura and Vidhyan hills from south and north of the trunk channel the most of these tributaries have short and precipitous course after they debouch from the hills. The area of sub basin of these tributatries is occupied by thick Quaternary sedimentsareclassified as older and younger alluvium on the basis of lithology sedimentological characters environments of sedimentation geological breaks. The banket of quaternary sediments of Sher Sakkar Dudhi inTawa and Ganjal, Hiran& Gaur.in Narmada valleyis chiseled in to two terraces besides present day flood plain. These terraces are designated as ST1 to ST2; SHT1 to SHT2, TT1 to TT2, and DT1 to DT2 resoectively.The landsacpe is entrenched and cut accross deep in quaternary blanket in to steeped sequence of terraces. These terraces are time equvalent to each other and have developed simultanoiosly during the same events.The incised blanket exposes lateral sedquence of quaternary sediment which depict hidden strata, unseen relict exposures of older deposits and signatures and imprints of neotectonisam.

The Narmada Rift valley formed a linear trench in the middle of Indian subcontinent was an

ideal locus for accumulation of sediments.The rift trench is intruded by the dolerite and other mafic and siliceous dykes and sills along lineaments in different phases of tectonic deformation. The Quaternary sedimentation incepting from glacial activity, followed by fluvio-glacial, lacustrine and fluvial phase within the rinsing and sinking environment, block faulting and segmental and linear displacement and dislocation, uplifting and isolated domal up- lift, Neogene rifting and Quaternary sedimentation and rift-bound Pliocene–Pleistocene rifting and volcanic activity specifically during glacial and fluvio-glacial phase are major component of the Quaternary period and tectonic processes of the Narmada Rift System which form the base of quaternary deposits.

The Quaternary events of the Narmada portys three prominent terraces and two sub terraces which are designated NT1 to NT3 and sub terraces NT2-A is NT2-B, NT2 B, besides NT2-C, NT3-A & NT3-B besides NT-0 in increasing order of antiquity. The terraces are described in detail separately. These are both erosional and depositional terraces and confined at an elevation of, between 280m to 310-315. The NT1 is being the youngest terrace and NT3- B it is being the oldest terrace identified in the valley .The realative disposition of these teraces is shown in the (Table No _2 to _7).

The Narmada has in the area under study has sculptured the alluvial tract into stepped sequence forming four alluvial terraces along its course. These are designated as NT0 to NT3 NT0 being the youngest terrace and NT-3 the oldest terrace. These terraces are separated by the scarp both curvilinear and linear in nature facing towards river side. These are abandoned flood plains represent the level of former valley floor in the area, and were formed by cumulative climato-tectonic changes in the watershed of Narmada in the Quaternary times.In Narmada NT0 and NT1 area depositional terraces whereas NT2 & NT3 are erosional terraces. These are both depositional and erosional terraces which are cyclic and non cyclic in nature and paired equvalent on both side of river. The Narmada exhibits swelling and pinching nature along its course of 1300 kms, between AmarkantakamdBharouch the channel course of Narmada is mainly controlled by ENE-WSW lineament and its sympathetic fractures. The Narmada in Jabalpur _ Harda and Gurdeshwar _ Bharouch section embodies prominent blanket of Quaternary deposits which display steepped sequence of river terraces. These terraces are seprated by linear and curvilinear scarp facing river.In Jabalpur _Harda section Hiran Dudhi, Shakker, Sher and tawa are the prominent tributaries.

The Quaternary plain of Narmada display fluvial terraces of the stepped topographic benches, which from the prominent Quaternary landscape flanking Narmada Valley, indicate the former levels of flood-plain or valley floor. These land forms have been formed by combined action of erosion and depositional process of stream, the up warping in the hard ward ends and consequent climatic change in the post-Pleistocene time.
The Narmada basin is bounded by Narmada north and Narmada south faults, located in the apex zone of northward convexity in the Narmada south fault. At places (e.g. around Hoshangabad), the northern limit of the basin transcends Narmada north faults. The Quaternary lithic fill rests over Gondwana sediments, Mahakoshals, Deccan Trap, Granites and Bijawars.

The Narmada plain is studded with ENE-WSW elongated ridges bearing imprints of polyphase folding in the Sihora Sleemanabad area. Denudational ridge in the Deccan Traps of Barela-Mandla region, show imprints of dominant ENE fabric.

The area studied evolved in response to topography and landscape profile in tectonic zone and reactivated superimposition of drainage o pre existing topography, lithology and structure. The Narmada Son lineament zones represent an interaction of lithology, structure and climate, illustrating time dependent reactivation history West, (1962;) Choubey (1971). The central part of the

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earthquake affected area is characterized by units of recent fluvial origin – Narmada-alluvium, whereas the area towards north exhibits units of Vindhyan syneclise, with valley and montane topography comprising hogbacks and cuestas. Further north, the syneclise has wide plateau with prominent scrap overlooking the Indo-Gangetic plains. Towards south in the Satpura block geomorphic units of extrusive origin with different levels of plateau, units of structural origin on the Mesozoic sediments and units of denudational origin culminate into high hill ranges with steep slope.

In the northern flank of Narmada on southern margin of Vindhyans, dominant geomorphic forms are hogbacks and cuestas, while towards north, plateau, mesa and butte are prominent gromorphic feature. This geomorphic pattern indicates post Vindhyan and pre-Gondwana reactivation of NNF (North Narmada Fault). Con-spicuous level-differences in the Gondwana-Deccan Trap contact surfaces reflect the nature of the main ENE fault and cross fault in the Satpura ranges. Elongated plateau, mesa and butte in Deccan Traps of Seoni-Mandla-Balaghat-Jabalpur district the dominant structural control over the evolution of landforms. Southwestern regional gradient of laterite capping in the Amarkantak region indicates adjustment of plantation surfaces during Tertiary period (Roy Chowdhury el al., 1964).

A chain of detached/isolated slices of Mahakoshal volcano-sedimentary rocks are noted on southern fault bound margin. Tiwari and Bhai, (1997),The detailed sedimenta -logical analysis of quaternary sediments of surface, both paleo and present domain of Narmada, bore hole sediments form surface up to the depth of 350 m below the surface , analysis of paleo-sole horizon ,quartz grain morphology of both e quaternary sediments and tephra soil and tephra stratigraphy, lithological assemblage, biostratigraphy and magnetostratigraphy have identified seven lithostratigraphic units o the surface of fluvial domain of Narmada, where the boulder bed represent the glacial phase at the base of Narmda trench boulder conglomerate glacial-fluvio and River terraces fluvial phase in increasing antiquity.The sediments of boulder bed and boulder comglomerate are concealed under younger deposits,are not fully exposed in the valley, however the detailed sedimentological ,haevy minerals , quartz grain morphology and paleo soles Khan et.al (1991). Khan et .al (2012) Khan et .al (2012) Khan et .al (2013) Khan (2014), Khan (2014), Khan et.al (2016) , Khan et.al (2015) Khan et.al (2016), Khan et.al (2016), Khan et.al (2016), Khan et.al (2016) Khan et.al (in press), khan et.al (in press) has established a record of Quaternary deposits from Lower Pleistocene to Holocene.

The Narmada valley in eastern and central segment exhibits a combination a mixed topography and quaternary plain with inselbergs, highlands and trappean plateau. The area in north and south of Jabalpur-Narsighpur-Hosangabad are occupied by plateau. The central part is a valley gape occupied by Quaternary sediments which have been accumulated in liear trench. This alluvial plain is drained by Narmada, Gaur, Hiran, Sher, Shakker, Dudhi, Tawa and Ganjal rivers and their tributaries. On the basis of altitudinal variation, five prominent geomorphic surfaces between 310 m and 585 m above MSL have been identified. The average elevation in the plain is around 390m MSL with the gradient from east to west. The plain is dooted with low inselbergs and mesas. The plateau in the southern sector attains an elevation of 585m MSL near Bamhni and in the northern area, the elevation is around 501m MSL near Bichhua village. In the eastern sector, Barela and Sihora area attain an elevation of 526m and 508m MSL, respectively. The southern plateau has a general ENE-WSW trend, while the northern plateau extends E-W. The highland and plateau show evidences of several cycles of erosion during the geological time. The plain of Gaur, Hiran and Narmada are accretional in nature.

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Plate No 1, 2, 3,

4. THE VOLCANIC ASH BED

The Quaternary deposit of Narmada Valley consists of sediments of three domain viz. deposits glacial, fluvio-glacial (interglacial) and fluvial. The boulder conglomerate is fossiliferous horizon of Narmada and has yielded skull cap of *Homo erectus* Narmadenesis Sonakia (1984).The Ash bed is found associated with Hathnora formation Khan et.at.(1991), in the area around Hathnora, upstream of Hathnora, Gurwara , Sardapur. The two horizon of Ash bed are identified in Boulder conglomerate (Hathnora formation). These are designated as NAB-I and NAB-II in ascending antiquity in the valley. The Ash bed NAB-1 is associated lower litho units of boulder conglomerate which is quite persistent and well preserved. The NAB-1 (L1 to L 3) contains three micro layer and NB-II (L-4 to L-5) two micro layers in increasing antiquity. The lower unit of boulder conglomerate is associated with NAB-I, where as NAB-II is associated with younger deposits. The study of grain morphology of glass matrix, their relation with other minerals shape, size, and texture of lithic fragments and association of other ashy sediments of pyroclastic origin suggest that sediments were brought from distant source by Aeolian agencies which fell and settled down during the different phases of sedimentation in valley. The Ash bed NAB-I is embedded within the reddish brown sand silt and in the upper pebbly girty unit of boulder conglomerate (Hathnora formation). It is grayish yellow, pink in colour fine grained and contain quartz, plagioclase, magnetite, rutile and litho fragments. The glass dominates over other minerals and few grains depict growth of radiating crystal or microlits. Fresh grains of plagioclase quartz and transparent glass are present in litho fragments in hyalo-ophitic fashion. The quartz grains are angular to sub-rounded, transparent, and fresh and contain grains of opaque as inclusion minerals. The crystal of quartz show sharp extinction. The plagioclase glass laths are angular in shape and crystals depict polysynthetic twining and normal zoning. The rutile and magnetite are anhedral in shape and occur as accessory minerals. The X-ray diffraction study of lower Ash bed NAB-I (Hathnora formation) indicates that it comprised of montmorillonite, quartz, albite and illite as major clay minerals and keolinite and calcite occur as traces.

The Ash bed NAB-II is associated with yellow, reddish, brown, clay and silt of fluvial deposits Khan et. al. (1992). It is pinkish grey, light brown in colour, fine grained, porous and non-plastic in nature. The average thickness is about 25 cms. The various minerals identified in the ash bed are glass, paragonite, quartz, plagioclase, which is mostly angular to sub-round in shape. The glass is found abundantly as small angular fragments, laths; shreds are present in ground mass matrix. These are colorless grains show very low relief and are isotropic in nature. The lithic fragments depict hyalo-ophitic texture. Fresh laths of plagioclase are next in abundance and depict polysynthetic twining. A few crystal show normal zoning. The quartz grains are angular to sub-angular shape and show sharp extinction. Beside few grains of anhedral clay particles and lithic fragments are also observed. The X-ray diffraction studies of upper Ash bed horizon

NAB-II reveal that it predominantly consists of quartz, albite, illite, kaolinite as major clay minerals and montmorillonite in traces. The results of chemical analysis are presented in
The study of grain morphology of glass matrix, their inter-relation with other minerals shape, size, texture of lithic fragments and association of other ash sediments of pyroclastic origin, indicate that they are the product of highly explosive silica volcanism. Pumice shards tend to develop from relatively high viscosity rhyolitic magmas with temperature less than 850 C whereas cuspate shards are most likely to develop from low viscosity rhyolitic magma with temperature more than 850 C suggest that sediments of pyroclastic origin and were brought from distant source by Aeolian agencies, after extrusive volcanic activity in middle and upper Pleistocene time.

5. PETROGRAPHY AND CHEMISTRY

The representative samples of Ash beds from column of Quaternary sequence were collected analyzed and studied for Petrographical and chemical aspects. The results are depicted in Table No.12. The volcanic component of the tephra in all the samples is represented by colour less and transparent, unaltered, coarse to fine ash sized glass shards. The morphology of shards was studied under both petrological and scanning electronic microscopes. The shards include bubble wall shards and pumice, with the former dominating over the latter. These are highly angular and range in size from 10 to 435, with a majority in 60 to 100 size class.

Pumice fragments are fibrous in nature and show parallel or sub parallel alignment of pipe vesicles. These commonly have straight margins, but curvilinear and irregular (contorted) margins also occur, and these patterns determine the shape of the pumice fragment. Adjacent pipe vesicles may coalesce to form a single structure within the pumice fragment. Most of the pipe vesicles are flattened in cross-section with length to width ratio always greater than 20. Entrapped, unreformed and stretched bubbles may occur either singly or together within a pumice fragment Tubular shards derived from fragmentation of pumice are also present. (Khan et.al. in press)

Morphological characters of these shards are typical of silica volcanism (Heiken, 1972, 1974) and show close similarity with those reported from the Quaternary tephra beds of the Narmada , Son, Purna and Kukdi basins (Basu et. al., 1987; Khan et.al. 1991 Basu and Biswas, (1991) and Shivaji, (1991); Mukhopadhyay, 1992).

It has been established that a broad relationship exists between color and chemical composition of shards and also that the chemical composition of parent magma which determines to a large extent the shard morphologies (Fisher and Schmincke, 1984; Heiken, 1972, 1974). The tephra under study confirm to be of acidic composition on the above criteria. Refractive index and SiO_2 content of glass have an inverse relation relating to glass shards of the tephra from the Narmada basin. The RI values show a narrow range of from 1.498 to 1.500, as determined by liquid immersion method.

The chemical analyses by wet chemical method of Narmada Ash Beds NAB-I (L-1 toL-3) and NAB-II (L-4 to L-5) were carried out and results are incorporated in

The Toba eruption of 74 ka was distinctly and clearly a mega event of very great magnitude and intensity, far greater than any known historical eruption, suggesting it had very devastating impact and repercussions. It has change the global climate environment and ecology. There are many Questions and quarries from many quarters, however, as to the scale of these repercussions is concerned these were of sizeable magnitude and had significantly influenced middle and late Pleistocene Hominines in Narmada valley and Indian subcontinent. The effects of Toba eruption on the global scale has remarkably registered its impact with varying signature in Indian subcontinent depending upon the height of column, wind direction moisture density, matrix load and chemical composition

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of different gases association. The occurrences of Toba beds and their disposition in the Quaternary columns across different basins in Indian subcontinent are more on regional scale. As regard to Narmada basin the hazardous effects of Toba might have been localized, whereby individual habitats or ecosystems were affected, yet other areas in region remained unscathed.

There are quarries and questions that necessitate consideration of two separate aspects of the eruption; first, the consequences of possible rapid global climatic deterioration and second, the direct effects of the ash-fall on hominines and their environments in Narmada valley and in Indian subcontinent.

The association of Ash bed NAB-I with Hathnora formation at the depth of 78 m in Quaternary column of Narmada and occurrences skull cape *of Homo erectus* of Narmada at the depth of 83 m assumed that Toba eruption might have taken place later than that of existence of *Homo erectus* which appeared and resided in the valley for long time before the fall of Toba ash. The association of Ash bed NAB-II at the depth of 72 m with the younger deposits indicates the second cyclic of fall of Toba ash which might have influenced the younger Hominines i.e *Homo erectus* & *Homo sapiens*, in Narmada valley. Though the correlation and assessment has its own limitation due to limited occurrence of human remains in Indian subcontinent. In this context it may be mentioned here that Theobold (1860, 1881) was first to study the Quaternary deposits of Narmada in the following year Late (1881) recorded a human cranium (transported), which was identified as *Homo sapiens*, supposed to have come from conglomerate bed of Lower Group. Unfortunately the cranium specimen was lost in the museum of the Asiatic society of Bengal, hence the find remained inconsequential. The fossil of human cranium *Homo sapiens* and skull cape *of Homo erectus* (Sonakia1984) are only human remains from Indian subcontinent and associated with lower Group of conglomerate bed. The occurrences of these skull caps with short range of their occurrences in the stratigraphic column of Narmada with the Ash beds horizon NAB-I and NAB-II and specially with the Hathnora formation one at the top at an average elevation of about 268-273 m above the mean sea level and other with younger deposits had revealed the close association with volcanic activity with their existence. The Toba Ash fall is also in very close range with the sequence of sedimentation and occurrences with both the skull caps, which certainly has its impact on the middle and late Pleistocene Hominines in Narmada valley and Indian subcontinent.

The oldest fossil from India is represented by the Narmada hominine dated to not less than 236 ka (Cameron et al., 2004), or to some time in between 150 and 250 ka (Kennedy, 2001:167). Modern human remains have been discovered in an undated Late Paleolithic context at Bhimbetka rock shelter III-A-28 (Wakankar, 2002:5) which is situated about 70 km north of Hominid locality Hathnora and from three cave sites in Sri Lanka, dating from 27.7 ka (Kennedy 1999, 2001).Using phytogeographic data, Oppenheimer (2003) argues that *H. sapiens* occupied India before ~74 ka and may have undergone "mass extinction" as a result of the Toba eruption. The later argument is in conformity with the observation of authors as it is well illustrated by close association of Ash bed and *Homo erectus* of in sediment sequence of Quaternary column of Narmada. (Plate No_4) Figure No 1 to 5

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7. CONCLUSION

The Narmada Rift valley formed a linear trench in the middle of Indian subcontinent was an ideal locus for accumulation of sediments.The rift trench is intruded by the dolerite and other mafic and siliceous dykes and sills along lineaments in different phases of tectonic deformation. The Quaternary sedimentation incepting from glacial activity, followed by fluvio-glacial, lacustrine and fluvial phase within the rinsing and sinking environment, block faulting and segmental and linear displacement and dislocation, uplifting and isolated domal up- lift, Neogene rifting and Quaternary sedimentation and rift-bound Pliocene–Pleistocene rifting and volcanic activity specifically during glacial and fluvio-glacial phase are major component of the Quaternary period and tectonic processes of the Narmada Rift System which form the base of quaternary deposits.

The Quaternary deposit of Narmada consists of sediments of three domain viz. deposits glacial, fluvio-glacial (interglacial) and fluvial. The Boulder bed identified at the bottom of basin is of glacial origin, Boulder conglomerate-(Hathnora formation) in the form of persistent wedge is of fluvio-glacial origin and fluvial deposit of palaeo-domain of Narmada is of fluvial origin, Khan & Sonakia (1992). The boulder conglomerate is fossiliferrous horizon of Narmada and has yielded skull cap of *Homo erectus* (Narmada Man) (Sonakia 1984). It is marker horizon and represents interglacial phase in the history of Quaternary sedimentation.

The Ash bed is associated with column of Quaternary sediments of Narmada with Hathnora formation and younger deposits. These are two horizons designated as NAB-I and NAB-II in ascending antiquity in the valley. The Ash bed NAB-1 is associated lower litho units of boulder conglomerate is well preserved and persistent horizon, where as NAB-II is discontinuous dissected and isolated in nature and associated with younger deposits. The Ash bed NAB-1 contains three micro layer (L-1 to -L3) and NAB-I1 two micro layers (L-4 to L-5) respectively.

The study of Ash bed matrix revealed the presence of various minerals like glass, paragonite, quartz, plagioclase, which is mostly angular to sub-round in shape. The glass is found abundantly as small angular fragments, laths, shreds as ground mass in lithic fragments. These colorless grains show very low relief and are isotropic in nature. The quartz grains are angular to sub-angular shape and show sharp extinction. The X-ray diffraction studies of Ash bed revealed that it is predominantly consist of quartz, albite, illite, kaolinite as major clay minerals and montmorillonite in traces.

The study of grain morphology of glass matrix, their relation with other minerals shape, size, and texture of fragments and sediments of pyroclastic origin suggest that sediments were brought from distant source in the form of thick cloud containing dust matrix and volcanic ash which was highly explosive and siliceous in nature and remained in atmosphere for quite long time. The height of the eruption column appears to be considerable. It is postulated that the tephra preserved as disconnected bodies within the river valley sediments represent rapidly settled ash falls from a volcanic ash cloud which formed a canopy over a large part of river basins for longer time of Peninsular India where sedimentation was on in different river basins including Narmada valley. The discontinuity of Ash bed in Narmada valley and Indian subcontinent is attributed to be associated with column of volcanic eruption, quantum of volcanic matrix, wind direction, moisture density of air and rate of fall of matrix on oscillating platforms of sedimentation in different basin**.** It is significant to note that the occurrences and association of two marked horizons at different levels further reveal that the cyclic eruption and settling of volcanic matrix was with pause in the valley which perhaps related with pause in volcanic eruption

The volcanic eruption and consequential ash fall has created severe dislocation in ecology

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and environment and adversely affected hominines in Narmada valley and Indian subcontinent. It is witnessed by association of Ash bed NAB-I with Hathnora formation at the depth of 78 m in Quaternary column and occurrences skull cape *of Homo erectus* at the depth of 83 m in decreasing antiquity from the top assumed that Toba eruption have taken place later than existence of *Homo erectus* which appeared and resided in the valley for long time before the fall of Toba ash. The association of Ash is NAB-II at the depth of 72 m with the younger deposit revealed the second cyclic fall of Toba ash which have had influenced collective and cumulative the *Homo erectus* (Sonakia1984) *Homo sapiens* (Thobold 1860, 81), in Narmada valley and Indian sub-continent.

The study of cyclic Toba ash fall and using phytogeographic data, Oppenheimer (2003) argues that *Homo. Sapiens* occupied India before ~74 ka and may have undergone "mass extinction" as a result of the Toba eruption. The argument of Oppenheimer (2003) is in strong conformity with the present observation of authors. As sediment & Ash bed sequence of Quaternary column of Narmada (325m) and occurrences of fossil of skull cape *of Homo erectus* (Sonakia1984) at 83 m & human cranium *Homo sapiens* (Thebold 1960,1981) (transported) have rarest occurrences of human fossils in Narmada valley and subcontinent which also confirm the intensive impact of volcanic ash fall on these hominines and their consequential mass extinction caused by mega dislocation in ecology and environment by volcanic eruption.

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